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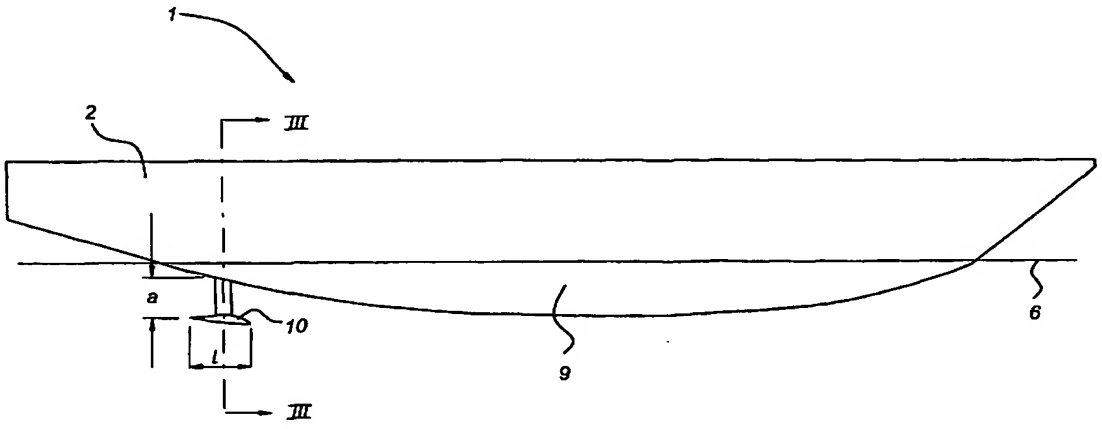
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: VESSEL PROVIDED WITH A FOIL SITUATED BELOW THE WATERLINE



(57) Abstract: Non-planing vessel with single hull (2). A foil (10) is fitted below the waterline at the place where the greatest flow constriction exists, in other words at the transition from the relatively broad part (9) to the narrowing part. This foil is situated at a distance from the hull (2) and preferably extends horizontally over as large a part of the hull as possible at a constant distance from the latter. The foil is designed in such a way that, apart from a lifting force, a forward propelling force is exerted. The performance of the vessel can be improved by fitting such a foil.

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Vessel provided with a foil situated below the waterline

The present invention relates to a vessel with a single hull, the aft part of which has a smaller water displacement and less breadth lying in the water than the middle part, and provided with a foil extending below the waterline.

Such a vessel is known in the prior art. In particular, planing vessels are sometimes provided near the end with a foil or flap extending below the hull, in order to ensure that during planing the trim angle that the hull forms with the surface of the water is limited. Such planing vessels generally have a hull that does not change substantially from the middle part in the aft direction.

An example of such a construction is found in US 2,832,304; 4,915,048 and the Abstract of Japanese Patent Application 62008893. In these cases the foil is situated on the aft side of the vessel, and a downward force is generated. Such vessels have no constriction of the submerged part of the vessel, in other words the cross section of the submerged part of the vessel (perpendicular to the direction of movement of the vessel) does not increase in the aft direction.

Furthermore, some catamarans are provided with fins for the purpose of reducing ship movements in waves. Such fins do not, however, have a foil profile. An example of the use of these fins in a boat is found in US-A-3.208.422.

The present invention relates to a non-planing vessel such as a sailing boat or a motor-driven vessel. It can be a relatively small vessel such as a leisure vessel or a large vessel such as a tanker, container ship and the like. Such vessels are provided with a constriction, in other words the cross-sectional surface area decreases in the longitudinal direction of the vessel, viewed in the aft direction. Such a reduction of the cross-sectional surface area is at least one third, and is normally approximately 50% from the point with the largest cross-sectional surface area of the submerged part of the vessel to the point with the smallest cross-sectional surface area of the submerged part of the vessel. At the position of a constriction the flow of the water will be directed upwards and/or inwards.

More particularly, in the case of such vessels the transom is not submerged in the water, but lies above the waterline.

It is the object of the present invention to improve the sailing characteristics of such a vessel.

This aim is realised in a vessel of the type described above in that said foil extends substantially transversely to the longitudinal axis of said vessel, lying at a distance below the hull over a breadth comprising at least half the breadth of said hull at the position of the greatest flow constriction of said vessel caused by said reduction in water displacement.

The terms length, breadth etc. are used in this description. These terms are associated with the position of the vessel in the water while it is being propelled in the usual direction. The direction of propulsion is the longitudinal direction in this case.

According to the present invention, a foil (profile) is provided near the place where the greatest flow constriction occurs. This foil is arranged in such a way that, apart from an upward lifting force, a forward propulsion force is provided. This propulsion force manifests itself by faster travel in the same conditions or by reduced fuel consumption, or by both of these.

According to an advantageous embodiment of the invention, the distance from the foil to the hull is substantially constant over its full breadth. In other words, the foil follows the shape of the hull precisely at a distance that does not vary.

The foil preferably extends over the greatest possible part of the "breadth" of the hull. In practice, this means that in the normal vertical position of the vessel the foil extends until close to the waterline.

It will be understood that this does not necessarily have to be the case in relatively broad vessels such as some types of merchant vessels, for example large oil tankers or container ships. The fact is that in these cases the length of the foil below the hull is already such that the part of it extending to the waterline would make only a small contribution to the effect described above.

The breadth of the foil is, however, important in the case of smaller vessels such as sailing vessels.

Unlike the structure in the prior art, where the foil is used during planing and in that case can be moved between a position for planing and an ordinary sailing position, according to an advantageous embodiment of the invention, the foil according to the present invention is arranged immovably on the hull, and the distance from and orientation in relation to the hull is invariable.

According to an advantageous embodiment of the invention, the length of the foil, in other words the size in the longitudinal direction of movement of the vessel, is at least 50% of the distance from the hull and is no more than 150% of said distance.

The length of the profile decreases in the outward direction from the longitudinal axis of the vessel. The rear edge preferably tapers off.

In experiments it was found that the overall hydrodynamic resistance of a vessel can be reduced with the foil used above. It was also found that the stern wave of the vessel concerned is reduced, which results in a further restriction of the resistance. These effects are greater than the resistance encountered by the foil through the water, so that a net positive result remains. Furthermore, it is possible to limit the trim of a vessel with the foil.

The invention will be explained in greater detail below with reference to an exemplary embodiment illustrated in the drawing, in which:

Fig. 1 shows diagrammatically in side view a vessel according to the present invention;

Fig. 2 shows the vessel according to Fig. 1 in top view; and

Fig. 3 shows the vessel in rear view.

The vessel according to the present invention is indicated in its entirety by 1. It comprises a hull 2 which, as can be seen from Fig. 2, is provided with a fore part 3, which broadens out increasingly in the direction of movement of the vessel. Connected to it is a middle part 7 of substantially constant breadth, and following that a tapering aft part 4. A considerable flow constriction occurs at the transition between part 7 and part 4.

As can be seen from Fig. 1, the aft end of the vessel sometimes projects above the waterline.

The longitudinal axis of the vessel is indicated by 8. A foil is fitted under the vessel. This foil is fixed in an immovable manner on the vessel by means of supports 11. The distance between the foil 10 and the hull 2 is constant and amounts to a. The length l at the position of the axis 8 is preferably approximately equal to the distance a. The length l of the foil decreases from the longitudinal axis 8 to the sides of the vessel, as can be seen from Fig. 2. The longest length is indicated by L in Fig. 1, while the shortest length is indicated by L_1 in Fig. 2. This reduction of the length is obtained owing to the fact that the rear side of the foil tapers. The breadth b of the foil is preferably at least three times, and more particularly at least four times, the length L of said foil.

As can be seen from Fig. 1, the profile is of such a shape that it causes a lifting force to be produced by the local flow rate at that point. Owing to the fact that the

local flow is directed obliquely upwards (and backwards), this lifting force is not directed purely vertically, but slightly forward. The resultants arising from this have a component in the forward direction.

The foil can be made of any material known in the art. This material depends on the application. For competition boats it will be a light material, such as a material impregnated with carbon fibres. In the case of freight ships the material used will be steel or aluminium. A reduction in resistance of over 5% was found during experiments.

After reading the above, persons skilled in the art will immediately think of variants that are obvious after the above. These variants are considered to lie within the scope of the appended claims.

Claims

1. Vessel (1) with a single hull (2), the aft part (4) of which has a smaller water displacement and less breadth lying in the water than the middle part (7), and provided with a foil (10) extending below the waterline, characterized in that said foil (10) extends substantially transversely to the longitudinal axis (8) of said vessel, at the position of the greatest flow constriction of said vessel caused by said reducing water displacement, lying at a distance (a) below the hull over a breadth (b) comprising at least half the breadth of said hull at the position of the greatest flow constriction of said vessel caused by said reducing water displacement.

2. Vessel according to Claim 1, in which the distance of said foil from said hull is substantially constant over the entire breadth.

3. Vessel according to one of the preceding claims, in which said foil extends to the waterline (6).

4. Vessel according to one of the preceding claims, in which the position of said foil relative to said hull is fixed.

5. Vessel according to one of the preceding claims, in which the length (L) of said foil is at least 50% of the distance (a) of said foil from the hull.

6. Vessel according to one of the preceding claims, in which the length of said foil decreases in the outward direction from the longitudinal axis (L_1).

7. Vessel according to one of the preceding claims, in which said foil is designed in such a way that during the forward movement of the vessel it exerts a forward propulsion force on said vessel.

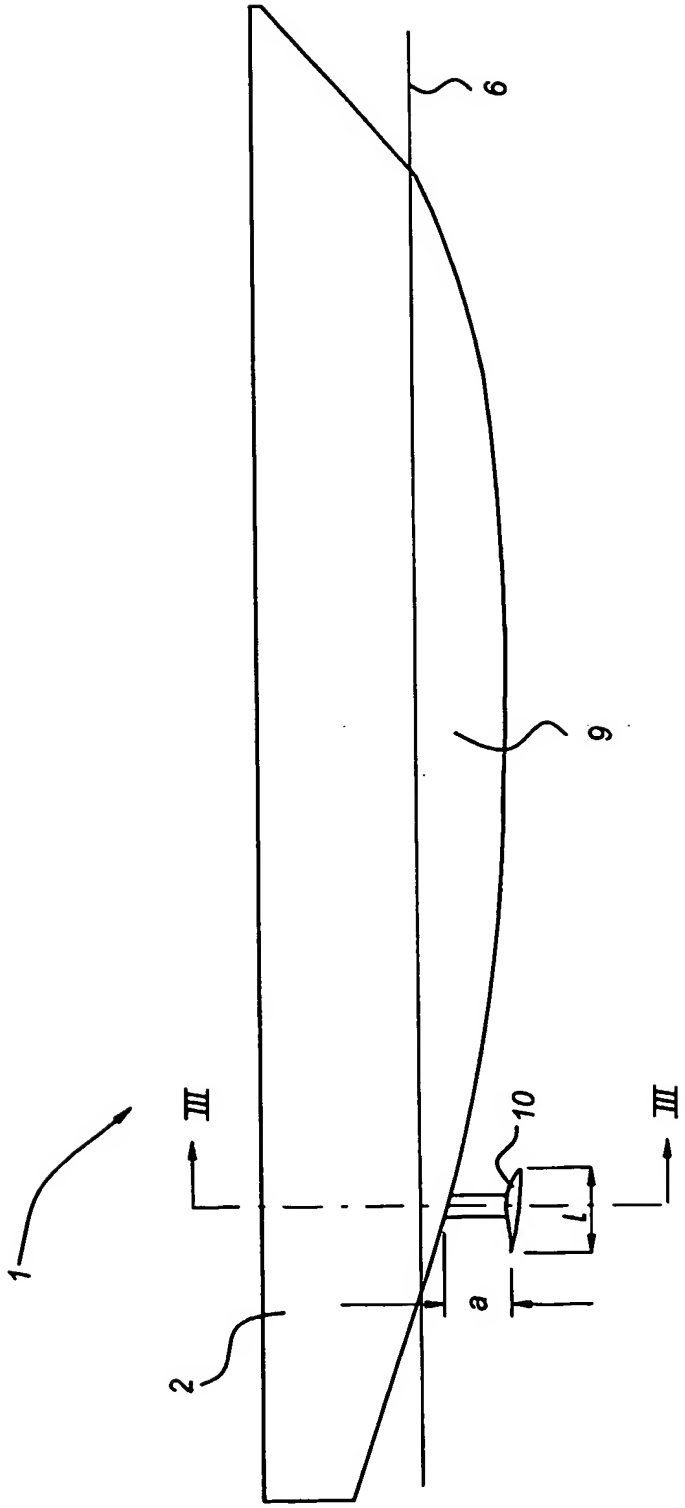

Fig 1

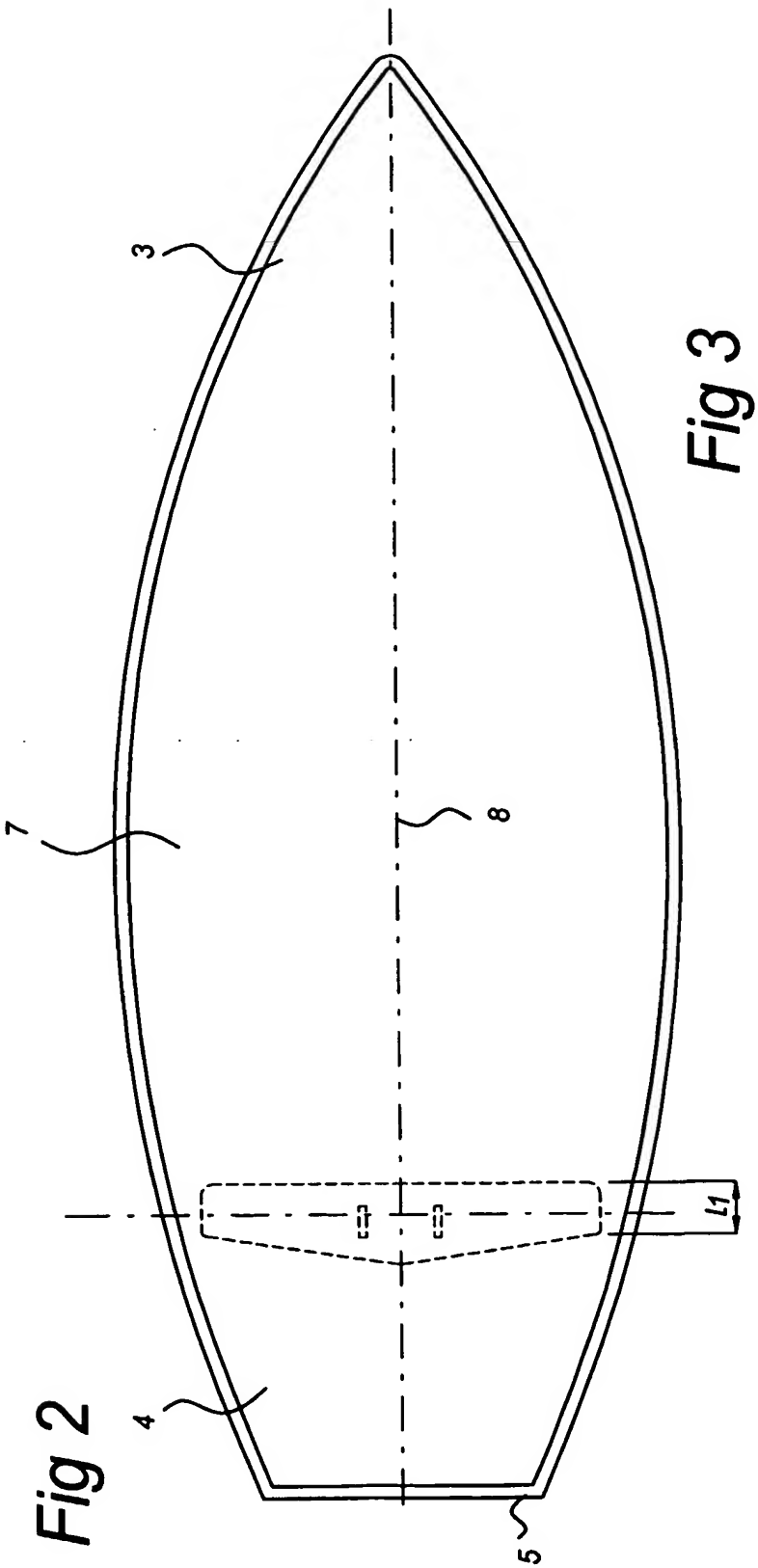

Fig 2

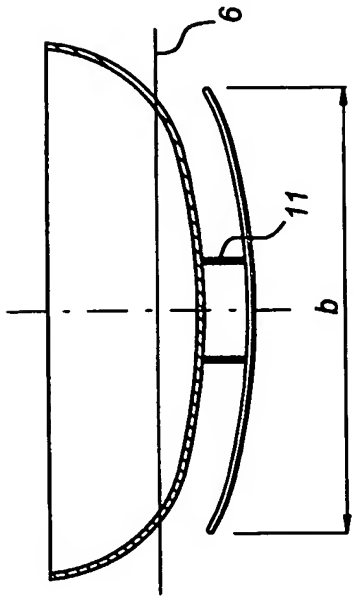

Fig 3

INTERNATIONAL SEARCH REPORT

Interna al Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B63B39/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	FR 1 541 693 A (STEINBERG AMIRAM) 11 October 1968 (1968-10-11) page 2, left-hand column, last paragraph -right-hand column, paragraph 1; figure 4	1,2,4 3
X	US 2 832 304 A (ELYOSIUS DONALD A ET AL) 29 April 1958 (1958-04-29) the whole document	1,2,5
X	PATENT ABSTRACTS OF JAPAN vol. 011, no. 180 (M-597), 10 June 1987 (1987-06-10) & JP 62 008893 A (MITSUBISHI HEAVY IND LTD), 16 January 1987 (1987-01-16) abstract	1,2,4

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 December 2003	10/12/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	DE SENA HERNAND.., A

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 208 422 A (SCHOPMEYER RICHARD W) 28 September 1965 (1965-09-28) figures 1-7	1,6
Y	US 4 628 853 A (HOYT JOHN G) 16 December 1986 (1986-12-16) column 2, line 29 - line 59; figures 1-8	3
A	US 1 852 680 A (CHARLES SHAW) 5 April 1932 (1932-04-05) the whole document	1,7

INTERNATIONAL SEARCH REPORT

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US 2832304 A	29-04-1958	NONE	
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US 3208422 A	28-09-1965	NONE	
US 4628853 A	16-12-1986	NONE	
US 1852680 A	05-04-1932	NONE	

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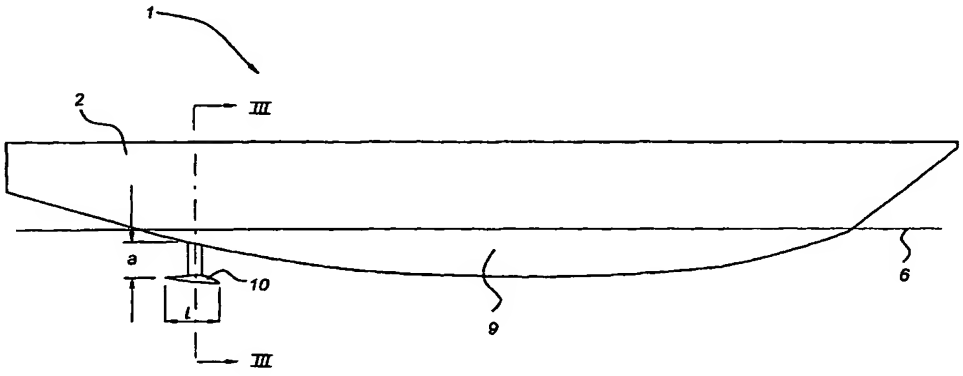

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